4. *In-building penetration*

a. Echo Group's Position

Page 10, Petition for Rulemaking: "Unlike the 220-222 MHz frequencies subject of the Commission's PR Docket 89-552 proceeding, the 930-931 MHz frequencies will afford greater in-building penetration crucial to the types of MDRS applications described above. Further, were the Commission to assign 10 channels of 5 KHz each to each MDRS licensee, Echo could operate TDMA channels at bit rates of 2,400 (nine channels), 4,800 (five channels) or 9,600 (three channels) per second and transmit power levels of 20, 23, or 26 dBm, respectively."

b. PageMart's Response

Contrary to Echo Group's claim, 220 Mhz frequency has very good building penetration characteristics. In fact, for the few transmitter base stations Echo intends to construct in typical major urban areas, the 220 MHz band would appear even better suited to MDRS. At 930 MHz using the power levels Echo proposes for a 5 KHz channel, however—namely 100 miliwatts—it is almost inconceivable that communication can be reliably established with a mobile unit within a building (i.e., 2400 BAUD at 20 dbm). If the MDRS system cannot support in-building transmission because the return link or forward link cannot reliably be established, the service will almost by definition be limited to very small niche market segments that are more adequately served by other data service providers.

Echo's approach also indicates that it is attempting to "port" technology intended for use at 220 MHz frequencies to 930 MHz in hopes of gaining a spectrum allocation without fully considering the implications of operating at 900 MHz. Echo

states that it has filed for commercial and non-commercial licenses in the Commission's recent allocation of the 220-222 MHz band. For established public policy reasons, the Commission should not allocate the reserve paging band to narrow band technologies better suited to operation on conventional paging frequencies.

SUMMARY

In summary, Echo Group's MDRS proposal represents a dedicated, packet cellular network, with virtually the same cost structure associated with cellular systems—yet without the economies of scale achieved by cellular networks—and requiring increased infrastructure costs as a result of tighter co-channel interference standards. Because the MDRS proposal compares very unfavorably with both conventional paging and more flexible wireless messaging systems, and because the in-building performance limitations of MDRS will preclude meaningful "portability," it cannot conceivably serve as the basis of a truly "advanced" wireless messaging delivery system.

E. MTEL NATIONWIDE WIRELESS NETWORK (RM-7978/PP-37)

OVERVIEW

The proposal by Mobile Technology Corp. (MTel) for a Nationwide Wireless Network (NWN) is a small but entirely inadequate step toward providing a truly "advanced" personal messaging service. The MTel system, based on multitone modulation of the forward channel, employ a simulcasting model just as used by Mtel's present nationwide paging system SkyTel. As a result of simulcasting large geographic areas for polling subscriber units and transmitting data—under NWN the entire continental U.S. would be divided into just 34 simulcast zones—total data

throughput is severely limited. Using reasonable busy hour assumptions for peak load, the NWN system would be limited to serving just 3,700 subscribers in a major metropolitan area such as New York City. In contrast, existing paging systems, such as PageMart's in Texas, can deliver more total throughput to subscribers statewide than an NWN zone. And in light of the simulcast design of the system, NWN capacity increases are virtually impossible due to co-channel interference (see Exhibit 3), meaning that the NWN "nationwide slot" would be required to carry a disproportionate amount of total traffic due to zonal overlap interference.

Other features of the NWN system raise critical problems as well. First, the complex modulation scheme proposed is significantly different from CT-2 and paging technology, necessitating more complex subscriber equipment, and includes a more limited and unreliable return link. Second, modulation schemes more efficient than MTel's proposal have been developed to achieve even higher data rates in a 25 kHz channels. Third, the power requirements attendant to NWN devices (7 watts) fundamentally compromise the essential criterion of "portable" wireless communications and raise serious concerns about battery drain and device size.

Accordingly, NWN fails most of the key features of an "advanced" wireless messaging service:

- simulcast capacity constraints essentially preclude the transmission of lengthy facsimile files
- throughput measured in total bits delivered to total subscribers is severely limited

- scarce spectrum is used inefficiently both within zones and in the "nationwide slot"
- it does not offer system capacity for a large number of users regionally and nationally
- it imposes a penalty on the complexity, size, weight, power consumption, price and portability of the subscriber communications device

SPECIFIC ISSUES

1. System capacity

a. MTel's Position

Pages iv-v: "NWN will address the need for a universal, highly flexible open access data transmission medium."[12]

b. PageMart's Response

MTel proposes a packet-switched data system that relies on simulcasting transmitters in a large geographical area for the purpose of polling subscriber units and the transmission of data. The obvious problem with using a simulcast approach to transmit data in large geographical zones (of which, according to MTel, the U.S. could be one or divided into 34 zones, some including more than one state) is that the data throughput is significantly limited and will, in turn, limit either the number of subscribers on the system or limit the services available. Accepting the definition of spectral efficiency to be bits delivered divided by (Hertz X secs. X sq. mi.), or alternatively bits delivered per frequency domain, time domain, and space domain, MTel has omitted the critical space domain variable of all modern wireless systems which is frequency re-use within a metropolitan area. Instead, according to

[12] All citations in this section are to the MTel petition for rulemaking in RM-7978, filed November 12, 1991.

MTel, NWN zones "will likely cover more than one state" (Page B7.) For example, if the state were Texas with four major cities—Dallas/Ft. Worth, Houston, San Antonio and Austin—with conventional paging systems operating at 2,400 BAUD, each city operating as a separate simulcasted system would have an effective throughput of 19,200 bps per state for 2-25 kHz channels or approximately 119% of the 16,080 (24,000 bps less 33% system overhead) per 50 kHz channel.[13] Therefore, MTel is offering nothing new relative to existing paging technology. Since it is beyond dispute that existing paging technology cannot cost effectively offer the advanced messaging services, MTel will not be able to cost effectively offer the facsimile, graphics and lengthy text messaging capabilities envisioned for the 930-931 MHz reserve band.

Another perspective similarly demonstrates that the capacity constraints of NWN are readily apparent. PageMart estimates in its petition (RM-7980) that an average of 15,000 characters per subscriber per day during the 10-hour busy period is highly likely; this is equivalent to assuming that one fax page containing approximately 60,000 bits for one out of five subscribers can be expected during the 10-hour busy period. Under these conservative assumptions, NWN would be limited to serving only approximately 3,700 subscribers, assuming a 13% busy hour call rate, in major metropolitan areas the size of New York City with 18 million in population.

The simple fact is that simulcast systems are not an effective way of achieving high data throughput. Although MTel is not clear on just what geographical area

---

[13] When ERMES becomes available, four conventional paging channels operating in the above four Texas cities at 6,250 kHz would be equivalent to 50,000 bps for 2-25 kHz channels and well over three times the equivalent channel efficiency of NWN.

and how many zones would be simulcasted to achieve its 800,000 nationwide subscriber capacity estimate, the clear implication is that zones practically must be as large as states in order to avoid destructive interference in overlapping zones or to simply "locate" the subscriber with its return link receiver network as the subscriber terminal acknowledges the receipt of a data packet.

The basic problem with NWN is that any reasonable level of data throughput will not allow any contiguous major urban coverage area to be addressed, as implied in MTel's Exhibit B9, because destructive interference in the overlapping areas would result. This co-channel interference could increase to such a degree that the national data block zone would generate high message queues and force the system into "gridlock" by simulcasting the entire nation with interference-ridden local zone transmissions. This occurs because the "[n]ationwide slots are used primarily to pass an initial packet to a user terminal that does not acknowledge a zonal packet or a user terminal located in the interference area between two zones" (page A13). Clearly, if NWN systems attempted to create more zones within major urban contiguous coverage areas to create additional capacity through frequency re-use, widespread overlap causing destructive co-channel interference would occur because "[s]ignals to subscribers in each zone are transmitted simultaneously" (page B7). The end result of creating more zones through frequency re-use in major urban areas, where it is needed to serve demand , is to cause the nationwide slots to carry a disproportional amount of the total message traffic stemming from overlap interference, because the zonal slots default to national slots when messages can not be delivered in zonal coverage areas. See Exhibit 3.

Therefore, the only way to implement MTel's asserted capability of increasing overall system capacity by increasing the number of zones is for zones to be at least as large as major urban areas to substantially limit the zone overlap, causing destructive interference. This essentially limits the potential subscriber capacity to a conventional simulcast paging system operating at 16,080 bps in effectively two channels. As a practical matter, NWN is a system that can not gain capacity through frequency re-use in contiguous major urban coverage areas where a high level of messaging demand exists. Moreover, because the nationwide slot is used for location, re-transmission, and transmission to overlap interference coverage areas, subscribers will automatically have to sign up for nationwide service so that any local coverage pricing, if it were to exist, would not be based on the airtime or cost.

2. *Advanced messaging capabilities*

a. MTel's Position

Page 4: "MTel addresses a deficiency in commercial radio services designed to meet the growing data transmission needs of portable computer users."

Page 11: "NWN will allow virtually unlimited user access for message origination. NWN contemplates a fully open user community utilizing a variety of adaptable interfaces. At one end of the spectrum, institutional users will coordinate with NWN system operators to obtain individually tailored computer-to-computer interfaces that may include encryption, specialized mapping of symbols to data, and specific codewords. These institutional users will be able to establish X.400 connections between their E-Mail systems and the NWN system."

b. PageMart's Response

Although it is hardly conceivable for an advanced personal messaging service not to support wireless facsimile transmissions to its subscribers, NWN does not appear designed to deliver messages of the length and complexity actually demanded by business users. This conclusion is supported by the capacity limitations of any simulcast systems serving one or more large cities as well as the absence of any reference to facsimile in MTel's discussion of services to be provided. Instead, MTel appears to be focused on extending its present capability to support E-mail transmission, which is likely creating a problem in its nationwide text messaging system, where its affiliated paging company, SkyTel, simulcasts one third of the continental United States.

It is clear that NWN cannot support long messages, or wireless transmission of facsimile, without consuming available capacity due to the system approach of simulcasting large contiguous demand coverage areas. NWN capability to support a gross data rate of 24,000 bps is reduced to 16,080 bps by 33% system overhead (page A12) and is further reduced to a net data rate of 10,613 bps by 34% POCSAG-type forward error correction overhead (page A12). Thus, approximately 1,327 bytes or characters can be transmitted per 50 kHz channel per second. If the average message length is 3,000 characters and a 13% busy hour call rate, then about 12,000 subscribers could be served in a major urban area like New York City on a single 50 kHz channel. Another way to view this throughput capacity is that NWN could

alternatively transmit less than 80 facsimile pages per hour per simulcasted coverage area.[14]

As to the purported "open access" benefits of NWN, conventional paging systems can also interface with a wide variety of service and communications networks through commercially available gateways. The issue is supporting the data throughput and the cost per byte of data transmitted. As discussed previously, NWN does not have the throughput capable of supporting facsimiles, large data files or E-Mail that requires an X.400 connection and, consequently, the cost of service even on a limited basis would not be competitive with proposed alternatives such as PageMart's PIMS service.

3. *Asserted benefits of simulcast*

a. MTel's Position

Pages 6-7: "MTel's use of simulcasting is ideally matched to the coverage and spectrum requirements of the NWN service. . . . Simulcasting also fully utilizes available capacity at any point, both in frequency and time domains. . . . MTel's offering not only will provide effective transmission rates up to 24,000 bps, but also will allow capacity re-use."

Page 15. "For NWN messaging, MTel believes that high speed simulcasting offers the best solution. . . . Use of single frequency also will facilitate the

[14] Mobiltex charges 20 cents per 1,000 bytes or approximately $12.00 for a G4 facsimile transmission with similar rates for cellular data. If MTel is, as it claims to provide superior data transfer capabilities than current cellular, offering lower-cost service (page 9), then it would be willing to sell its airtime per hour in major urban areas like New York City for $1,000. The same hour on 2-25 kHz BAUD paging channels would have revenue of approximately $10,000/busy hour.

deployment of additional base stations within a system and simplify the design of portable terminals."

Page B7: "In actuality, the zones will be much larger than suggested in Figure B8. Thus, a zone will likely cover more than one state."

b. PageMart's Response

MTel extols the virtues of simulcast systems, but MTel in fact presents half truths when it claims that simulcasting also "fully utilizes all available capacity at any point, both in frequency and time domain" (pages 6-7). On its face, this statement is correct; however, spectral efficiency is defined as bits per frequency, time and space domain. MTel has conveniently overlooked the critical space domain component of all modern wireless communication systems, namely, frequency re-use within a local geographical area. In contrast, when it serves MTel's purpose to suggest greater capacity expansion, it draws on the notion of frequency re-use (space domain). Yet, as discussed above, the limitations of destructive interference in zone overlap areas effectively constrain NWN frequency re-use to zones as large as one or more states, which is not even as effective in simulcasting cities as conventional paging companies achieve with existing technology.

MTel is essentially thinking in only one dimensional terms, namely that the time domain is the key way to get more throughput and hence that the fastest data rate for a single channel is the best alternative. Furthermore, according to MTel, 24,000 bps in a 50 kHz channel appears better than 12,000 bps in a 25 kHz channel, therefore, choosing the 50 kHz solution is better even though 2 or 4 or more 25 kHz channels may provide significant trunking efficiencies (better management of

message queues), and cover fixed infrastructure costs better. How a single frequency will facilitate the development of additional base stations within a system defies all logic and engineering experience.

4. Asserted benefits of multitone modulation

a. MTel's Position

Page 14: "MTel's innovative design includes . . . Enhanced Multitone Modulation. Enhanced multitone modulation techniques, particularly appropriate for simulcast systems, will allow transmission speeds of 24,000 bits per second on a 50 kHz channel."

b. PageMart's Response

From a system engineering standpoint, NWN is similar in concept to many CT-2 approaches that use time division duplex (simplex two-way), except vastly more complicated. First, MTel is proposing a more complex modulating scheme than a typical CT-2 base station (72K bps pre-conditioned FM in a 100 kHz channel) operating as a single cell. Second, return link protocol is different and operates at 40% of the forward link speed or 9.6K bps, rather than with identical protocol operating at 24K bps. Third, the critical return link receiver is not one station transmitting and receiving, but rather a network of receivers which may be dispersed within a major urban area. Therefore, flow and error control of transmission is not achievable per standard data transmission requirements. Fourth, the operation of the base station is in simulcast mode with many others in a given zone, rather than an individual transmitter/receiver base station communicating with a subscriber. Fifth, the variable length batching will require

the receiver to be more complex, and to remain powered-up longer to decode messages relative to a fixed batch length protocol like POCSAG, which also allows for variable data length. Finally, virtually all aspects of NWN are significantly different so as not to take advantage of CT-2 or paging technology and related manufacturing learning curves. Therefore, it is highly unlikely that three NWN systems operating nationwide with less than 20,000 subscribers[15] each at capacity in one zone, constituting a major urban area, will be able to create sufficient volume for a new communications system to take advantage of volume cost reductions.

For obvious reasons MTel focuses its discussion on NWN's multitone modulation scheme for the forward channel, because increased data rates through higher BAUD rates and coding is essentially the only way NWN can improve on throughput relative to conventional paging. The problem is that different types of multitone schemes have been around for years, and the paging industry, as one communications service, has not adopted this approach. There are many likely reasons for this: (1) additional expense and complexity of the receiver; (2) higher density of transmitters to ensure overlap signal quality; (3) power requirements increase with higher BAUD rates; and (4) decreased reliability of transmission in saturated RF urban environments with high multipath interference. Moreover, even more efficient modulation schemes are available and, indeed, may be more suitable than the proposed MTel approach. For example, engineers at Matsushita

---

[15] 24,000 bits/sec. X 1 byte/8 bits X .67 system efficiency X 3,600 sec./hr. X 1 active subscribers/3,000 bytes (characters)/busy hour message X 100 total subscribers/13 active subscribers (busy hour) = 18,554 total subscribers with POCSAG link error correction total subscribers = 504/768 X 18,544 = 12,176.

Electric Company in 1980 developed a modulation scheme to meet FCC masking requirements that had an effective data rate of 16,000 bps in a 25 kHz channel. Consequently, with a wide variety of modulation schemes to choose from, the merit of an advanced messaging system approach like NWN should not be based on a particular one, but rather on the fundamental architecture of the system to provide for spectral efficiency, large throughput capabilities and the ability to support a large number of customers services with a wide range of data rate requirements.

5. *System design*

a. MTel's Position

Page 14: "MTel's innovative design includes:

- Nationwide Simulcasting. Simulcast operation will enhance coverage continuity and building penetration, as well as allowing low-cost network growth.

- Adaptive Zoning. NWN's architecture will provide automatic 'follow me' delivery of messages to users changing zones, enhancing operational efficiency.

- Variable Length Batching. Forward communications will be organized in repeating cycles. Each cycle is divided into dynamically adjusted address group time intervals, permitting efficient adaptation to variable load conditions."

b. PageMart's Response

MTel's notion of innovative design is not supported by the facts. First, nationwide simulcasting is the most spectrum-inefficient approach possible. Simulcast operation is a very good way of ensuring that short messages (or subscriber polling for location) get to subscribers of unknown location, but is a very

spectrally inefficient method for transferring data due to lack of frequency re-use and the reality that multiple transmitters with overlapping coverages are subject to higher error rate due to misalignments in modulation synchronizinations with which a single serving transmitter would not have to contend.

Second, high-speed modulations techniques have been available for years[16] and have not found widespread use due to the increased cost complexity of the receiver, the higher power drain on batteries and the need for more densely populated transmitter base stations resulting in increased network infrastructure cost.

Third, MTel uses adaptive zoning in three different ways in the text of its petition: (1) as a "follow-me" delivery message that stem from NWN's nationwide signalling to register subscribers acknowledging packets sent, (2) adaptive zoning to increase system capacity by simultaneously communicating to a number of user terminals located in separate areas, (3) adaptive zoning to enable MTel's model NWN system to increase throughput to satisfy demand. "This scheme would allow MTel's NWN system to reassign zone boundaries in real time to accommodate even temporary surges in traffic for particular zones. Dynamic zoning, however, entails complex signalling arrangements between base stations and the national control center, as well as a high level of computing power at the control center." (Page A8, footnote 10.)

Therefore, it is not clear what MTel believes adaptive zoning means. However, if MTel is proposing an adaptive or dynamic zoning scheme, it would

---

16 May 1980 IEEE, On A Method of Constant Envelope Modulation for Digital Mobile Radio Communication, Kouichi Honma, Eiichiron Murata, Yasuhiro Rikou Matsushita Communications Industrial Co., LTD. 16,000 bps in a 25 kHz channel that meets FCC masking requirements using PSK modulator and PLL circuit.

appear to be of very little value, given the lack of knowing the specific location of customers in high traffic density areas. In these circumstances, multiple zone overlaps would lead to the larger problems of destructive interference requiring loading up the national zone simulcasting (and pre-empting zonal transmissions), whereas in low traffic density areas, this would appear to be totally unnecessary.

Finally, variable length formatting is not necessary or an improvement over standard POCSAG, fixed-batch formatting because POCSAG permits variable message lengths to adapt to variable load conditions.

6. Error correction

a. MTel's Position

Pages A11-A12: "MTel plans on interleaving 24 codewords in BCH (31, 21), with an added parity bit through the address and message information in a packet."

b. PageMart's Response

MTel's system of correction is roughly equivalent to POCSAG's present coding. Although interleaving is better suited for handling burst error, it is roughly equivalent in dealing with random error. In any event, MTel's system shares an equivalent amount of overhead with present POCSAG. In addition, the preamble is 128 bits for this proposed NWN protocol, and POCSAG is 576 bits. If this new preamble just mimics POCSAG, it is at a disadvantage of 4.5:1 or 6.5db, precluding rate issues. If the objective of the Preamble sequence is to maximize the reliability of data clock synchronization or re synchronization, then 6.5db would be the loss at equal baseband energy per bit, which would require a significant increase in signal-to-noise ratio. In summary, POCSAG Preamble is significantly more effective than

the proposed solution. Also, it should be noted that (1) a leader signal has been added in front of the Preamble in the POCSAG protocol to cope with the false lock problem in POCSAG receivers (this problem has been eliminated with the new, less than two-year-old receivers), (2) the Preamble sequence is shorter than the standard POCSAG Preamble sequence, and (3) with the addition of higher data rate, the signal presents time, 45-90 times less than POCSAG, which is significantly less, which raises a significant question regarding NWN's potential for false sync and not acquiring sync.

7. Equipment power requirements and portability

a. MTel's Position

Page 23. "Portable user transmitters should be limited to a maximum power of 7 watts ERP in order to facilitate an environment in which both portable and vehicular mobiles can be accommodated."

b. PageMart's Response

MTel's suggestion that 7-watt subscriber terminals would be useful in both portable and vehicular mobile environments belies credulity. Seven-watt portable units: (1) stretch the term "portability" beyond any accepted current meaning, (2) would have very questionable battery, size and life characteristics, and (3) raise serious questions regarding health hazards for high usage applications that stem from 7-watt ERP radiation at 900 MHz to people in close proximity. If the future vision of personal messaging system points toward small, hand-held units that provide a wide variety of computer/communication features and are highly power-efficient using small batteries, then this "die hard" battery type requirement of

NWN is plainly inconsistent with what business users are already demanding of their wireless communications equipment, such as portable cellular telephones.

Besides the inevitable increase in cost, size and weight associated with such extraordinary power requirements, the greatest drawback to power transmission requirements of this magnitude may be health risks. Inasmuch as cancerous cells can be killed after exposure to four or five watts after an hour, the 7-watt maximum proposed by MTel appears dangerous.[17] PageMart suggests that power demands in excess of the present wattage required for cellular phones (0.6 watts) should be presumptively unreasonable. PageMart applied this standard when it designed a transmitter that works effectively at 0.1 watt.

8. System throughput models

a. MTel's Position

Page 17: "MTel modeled systems operating at both 18,000 and 24,000 bps, the predicted throughputs of the two enhanced modulation techniques MTel is considering. The model used variable message lengths up to 10,000 characters, with an average weighted message length of almost 3,000 characters. The model also postulated a well developed system with a number of multistate zones, but not a system at ultimate frequency re-use capacity. Using these assumptions and a 13 percent busy hour call rate, the model predicted that a 18,000 bps NWN system will accommodate over 600,000 users and that a 24,000 bps NWN system will accommodate over 800,000 users." See also Pages A12 ("Subtracting the bits used for

---

[17] United States Radiation Safety and Regulatory Considerations for Radiofrequency Hyperthermia Systems. H.I. Bassen, R.F. Coakley, Jr. Bureau of Radiological Health, FDA

error checking in each packet, NWN allows a total of 504 bits of data per 768 bit packet.") and B8 ("In NWN, a system built out to 34 zones will allow 34 fold re-use of all of the capacity assigned to zonal operation, which is effectively most of the cycle.")

b. PageMart's Response

It is very difficult to corroborate these MTel system throughput models because the data provided is so sketchy. However, if we assume (1) best case data rate of 24,000 bps; (2) an average message length of 3,000 characters; (3) AC II characters of one byte each; (4) 13% busy hour call rate; (5) 33% system overhead and 34.4% error correction overhead; and (6) fully loaded system, then—24,000 bps x 1 byte/8 bits x 3,600 sec/busy hour x 1 active subscriber/3,000 bytes (characters) x 100 total subscribers/13 active subscribers (busy hour) x (1-.33) system overhead x (1-.34) error correction overhead = 12, 176 total subscribers per zone. Therefore, there would need to be 800,000/12, 178 = 66 zones, not the 34 zones proposed by MTel.

9. Zone saturation

a. MTel's Position

Page A8: "Conceptually, when traffic is limited, a simple nationwide system (all messages transmitted to all locations) is an adequate solution for forward channel transmissions. As the throughput of the system increases in aggregate, however, transmissions are subject to prohibitive time delays at best, and capacity exhaustion at worst. When saturation is imminent, however, the NWN central computers will divide the whole area into two or more zones according to traffic demands."

b. PageMart's Response

It is clear that MTel expects NWN to function merely as an incremental extension of current nationwide paging services if approximately 13,000 nationwide subscribers (using 3,000 character message rates during busy hour) will saturate one zone, namely, the nationwide zone. Thus, zoning would appear to be needed almost from the start if NWN is truly going to address existing and projected consumer demand for advanced messaging services.

10. Return link considerations

a. MTel's Position

Page A14. "Very high capacity is achieved on the reverse channel due to independent data reception on a number of network receivers, allowing MTel to employ a simple modulation scheme (phase shift keying) with powerful error correction operating at only 9,600 bps (as compared to 18,000 to 24,000 bps on the forward channel)."

b. PageMart's Response

MTel recognizes on the return link the throughput capacity advantages of frequency re-use by having its subscriber terminals dispersed throughout a coverage area. Terminals are communicating only to small subgroups, allowing for multiple parallel communications simultaneously at much reduced date rates (i.e., 9,600 bps). However, the benefit of this simple receiver accrues to the few stationary receiver stations, not the subscriber terminal that must support 24,000 bps on the forward link, because MTel does not employ local frequency re-use.

11. Modulation asynchroneity

a. MTel's Position

Page B3-B4: "The degree of modulation synchronization required appears trivial, but attaining this level in practice is considerably more complex. There are at least three sources of asynchroneity:

- timing shifts in the delivery of the modulating waveform;
- timing shifts internal to the transmitter;
- propagation anomalies.

In current commercial practice, the summation of these three components results in time uncertainties of 200 microseconds, or baud rates of 1,250 baud. The equi-signal boundary wanders and the two boundaries no longer coincide. Thus, the residual time uncertainty for NWN is approximately 80 microseconds, yielding a maximum baud rate of approximately 3,000 baud."

b. PageMart's Response

All time shifts in wave form delivery and equipment transport delay that are sources of asynchroneity in modulation synchronization are currently addressed by modern paging systems using automatic control of base station transmitters. Motorola, Quintron and Complex systems can control time shifts down to 1 to 5 microseconds which allows baud rates up to 9,600. The other factor resulting in propagation anomalies still exist, but are minimized by distances between base stations; the closer together, the less the anomalies. Therefore, NWN's 3,000 baud rate limitation is simply due to MTel's proposed network design and the equipment used, but does not represent a theoretical upper limit or constraint to all modern simulcast systems.

12. Frequency re-use and zonal interference

a. MTel's Position

Page B5: "The classic alternative to simulcast for wide area coverage is assignment of orthogonal subdivisions of the available capacity to adjacent areas. . . . There are twoproblems with such systems, however. First, orthogonal assignments require tuning the receiver to the assigned channel for the area in which the receiver currently resides. Second, and more serious, the orthogonal assignment approach consumes capacity—anywhere from three to seven or more orthogonal assignments are required to obtain continuous area coverage (see Figure B7). Thus waste of capacity is somewhat recouped if the same information is not needed throughout the service area."

Pages B5 B6: "The cellular radio service is the outstanding example of this capacity re-use principle—the same frequencies are re-used in separate cells to carry different conversations. Identification of the specific area in which a subscriber is located is required to allow capacity re-use."

Page B7: "Figure B9 shows the area of Figure B8 divided into three zones. In actuality, the zones proposed for NWN will be much larger than suggested in Figure B8. Thus, a zone will likely cover more than one state. Signals to subscribers in each zone are transmitted simultaneously. Although there will be interference between different zonal signals in the overlap areas between zones (i.e., the areas with double shading in Figure B,9), reliable transmissions to users in those areas would take place during the nationwide service. Clearly, it is advantageous to minimize the number of messages sent to the overlap areas, so overlap areas are

engineered to fall on areas of low subscriber density. Subject to that constraint, it will be possible to further subdivide zones. The only constraints on this process are minimizing the number of subscribers in zone overlaps, keeping multiple transmitters in each zone to provide simulcast benefits and minimizing the number of zones that must be administered."

b. PageMart's Response

It is clear that either MTel does not understand frequency re-use or else is are attempting to avoid the discussion by dismissing the advantages of re-using the same frequency within a local area many times over (however, MTel does note that this is a good approach to achieving high capacity on the return link). For instance, a 40-transmitter system in a major metropolitan area like New York City could re-use the same frequency with simultaneous data transmission 10 times with a four-cell re-use scheme, (i.e., 40/4 =10). However, it becomes very clear when MTel discusses cellular radio service's re-use principle that the key enabling requirement of precise subscriber location is missing in the NWN system and, therefore, NWN can never be as spectral-efficient as cellular radio service.

This comment also underscores MTel's improperly equating capacity with a continuous region of coverage instead of the ability to accommodate message traffic. Orthogonal assignment does not consume capacity if done correctly. Taking a cue from the cellular industry, the further subdivision of cells increases capacity. The statement on MTel's Figure B7 apparently does not consider this possibility and is flawed in viewing existing cell size as given. Like the cellular industry, PageMart has learned this critical lesson and is not bound by MTel's own constraint.

As to interference, it is very evident that NWN cannot take advantage of meaningful frequency re-use to increase throughput and capacity because the zonal overlap areas cause interference (and subscribers would thus not receive messages). The only practical and available solution, according to MTel, is to use their most spectral-efficient tool, namely, nationwide simulcast time slots, to reach local subscribers who fall in a zonal overlap area. Thus, if NWN were to create many such zonal overlap areas, then the nationwide simulcast time slot would become the dominant simulcast zone and in turn become highly inefficient, congested and potentially cause substantial service delays.

13. Time division duplex parameters

a. MTel's Position

Page B5: "Simulcast operation avoids the need for scanning and re-tuning which can drive up the terminal power consumption. "

b. PageMart's Response

PageMart suggests that this is one of the key deficiencies of NWN in using variable, time division duplex. Unlike ERMES (Part 4: air interface specification), which has a well-defined, fixed structure, NWN necessitates wasted airtime and added terminal complexity by sending instructions as to when to expect message reception. NWN requires reception of instructions as to what time interval to potentially receive data.

SUMMARY

The proposal by MTel for a Nationwide Wireless Network (NWN) is a small but entirely inadequate step toward providing a truly "advanced" personal

messaging service. NWN cannot support large numbers of users or complex and lengthy messages, such as facsimile. The simulcast configuration of the proposed network fundamentally limits the total information deliverable to subscribers and, due to co-channel interference, precludes meaningful increases in system capacity through frequency re-use. As a result of statewide or larger zones, the power requirements for NWN equipment are so large that necessary portability will be all but impossible. In short, NWN manages faster data rates for message transmission, but the price of adopting this approach to throughput is to sacrifice all of the other central features of a truly advanced wireless messaging service.

CONCLUSION

PageMart's proposed "Personal Information Messaging Service" is the first truly personal, portable and ubiquitous wireless messaging service, and is clearly the only proposal now before the Commission which meets all the criteria necssary for an advanced messaging service meriting the allocation of scarce spectrum reserved for enhanced paging services. For all the reasons set forth in these comments,

PageMart's petition for rulemaking should be granted and PageMart should be awarded a pioneer's preference for opening of the 930-931 MHz paging reserve band.

Respectfully submitted,

PAGEMART, INC.

By: _____

Roger Linquist
Chairman & CEO
PAGEMART, INC.
6688 N. Central Expressway, Suite 900
Dallas, Texas 75206
214 750-5809

Jeffrey Blumenfeld
Glenn B. Manishin
BLUMENFELD & COHEN
1615 M Street, N.W., Suite 700
Washington, D.C. 20036
202 955-6300

Attorneys for PageMart, Inc.

Dated: June 1, 1992.